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MOISTURE CONTENT OF SEED COTTON IN RELATION TO CLEANING AND GINNING EFFICIENCY AND LINT QUALITY

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CONTENTS

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SUMMARY AND CONCLUSIONS

The moisture content of seed cotton is of considerable importance in the ginning process. Seed cotton that is too high in moisture content will not clean or gin properly and seed cotton of subnormal moisture content will be damaged by the gin stand. The seed cotton drier was developed to condition damp cotton prior to cleaning and ginning. In 1951, more than 6,400 gins were equipped with driers, which benefit the cotton producer and ginner, but these driers will not overcome faults due to improperly adjusted or poorly operated machinery.

The conditioning of cotton with driers increases the effectiveness of cleaners in the removal of trash. Laboratory tests have shown that, as the moisture content of the cotton decreases, the amount of trash removed by the cleaners increases. Drying temperatures as high as 300° F. have been observed in gins in an effort to obtain maximum grade improvement, regardless of reduced staple length and bale weight losses which are caused by excessive drying. Field observations showed that higher temperatures are used on machine-picked than on hand-picked cotton, and that gins which are not equipped with lint cleaners employ higher temperatures than do plants so equipped, and that because of the excessive drying the staple length was shorter at gins without lint cleaners. General practice in commercial gins is to use one or two driers on hand-picked cotton, and two or three driers on machine-picked cotton. When two or more driers are used, a higher temperature is usually maintained in the first drier with progressively lower temperatures in the remaining units. Field studies showed that intense drying produces doubtful benefits on relatively clean cotton but gives very pronounced grade improvements on machine-picked cotton.

Tests have also shown that moisture content affects ginning time. The ginning time becomes progressively greater as the moisture content is reduced.

Cottons of low moisture content also offer greater resistance to compression and are often responsible for damage to gin trampers and presses.

Seed cotton drying affects many quality elements of the ginned lint and cottonseed. Excessive drying causes reductions in fiber length and increases nep count, which results are reflected in reduced yarn strength and appearance grade. The tensile strength of the fibers is affected to a slight degree. The formation of free fatty acids is retarded in seed which are above 12 percent in moisture content when subjected to seed cotton drying. This reduces the tendency for the seed to deteriorate in storage and has a favorable effect on the germination or on the quality of oil produced.

Field studies showed that, over a 3-year period, 80 percent of the Yazoo-Mississippi Delta crop averaged less than 6 percent in lint moisture content, and about 45 percent of the crop had a moisture content of less than 5 percent. Thus, a large part of the crop has a lint moisture content as it leaves the gin considerably below the 7 percent that is normal for bales when opened at the mill. The producer, like others who handle cotton, has an interest in the weight gained by bales of subnormal moisture content. Although seed cotton is dried excessively in some areas to facilitate cleaning, an effort is made in other sections to add moisture for the control of static electricity. Numerous methods for static control have met with varying degrees of success, but no method has been entirely satisfactory. Tests have shown, however, that some of the damage resulting from overdried cotton may be prevented by increasing the moisture content of overdried cotton to near normal prior to ginning. Applying moisture after the lint is removed from the seed has been found to give no measurable quality benefits, serving only to restore some of the weight lost by overdrying and perhaps aiding to a limited extent in the control of static electricity. Tests showed that cotton retains only a relatively small percentage of moisture added by conventional methods in the wagon telescope and on the lint slide. The lower the moisture content of the cotton being handled, the higher is the percentage of moisture retained. The addition of moisture to very dry cotton at the wagon telescope gave an average increase of 1/16 inch in staple length whereas the addition of moisture on the lint slide had no noticeable effect. Fiber quality benefits resulting from restoring normal moisture content to overdried seed cotton prior to ginning are substantiated by spinning tests.

MOISTURE CONTENT OF SEED COTTON IN RELATION TO CLEANING AND GINNING EFFICIENCY AND LINT QUALITY

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INTRODUCTION

The moisture content of seed cotton has long been recognized as a factor of considerable importance in the ginning process. Seed cotton containing an excess of moisture is difficult both to clean and to gin, since damp seed cotton tends to become tangled or roped instead of staying single-locked as it is grown. The damp wads of cotton are troublesome, particularly because they cause chokages in the cleaning machinery and in the gin stand itself. Even though the gin stand may not choke completely, the ginned lint is rough in preparation and may even be cut by the gin saws into lengths shorter than normal. Furthermore, the damp cotton fibers cling tenaciously to trash particles present in the lock, thereby rendering the cleaning machinery practically useless. Thus, the ginning of damp seed cotton entails losses and extra expense to both the gin owner and the cotton producer.

GIN DRYING EQUIPMENT--ITS DEVELOPMENT AND USE

Early attempts to avoid ginning excessively damp seed cotton included drying by shaded exposure, sun drying, and storage. All these methods had serious shortcomings but were practiced until the late 1920's. About that time, the first practical seed cotton driers were developed by the U. S. Department of Agriculture, followed soon thereafter by the vertical and various other designs produced by gin equipment manufacturers, and installed at an increasing rate in commercial gins.

The success of drying cotton artifically at the gin is attested to by the fact that, by 1951, more than 6,400 of the 7,732 active gins--or about 81 percent of the gins--in the United States were equipped with some means for drying seed cotton as a part of the ginning process.

The use of cotton driers provides benefits to both cotton producer and ginner in one or more of the following ways: (1) The driers condition the seed cotton for smoother and more uninterrupted operation of the gin plant by removing excess moisture and by fluffing the partially opened locks; (2) the dried cotton gives up more of its foreign matter content than would otherwise be the case; and (3) the ginned lint is smoother than that from undried cotton so that no grade penalty due either to rough preparation or gin cut is assigned to the bale. It should be pointed out, however, that a seed cotton drier will not overcome faults due to poor condition of equipment or improperly adjusted or operated machinery, even though it may reduce the effects of these faults to some extent.

Seed cotton drying as now practiced in modern gin plants has progressed from the single tower to as many as three driers of various designs placed at intervals for use in combination with other equipment employed in the cleaning process; also, the practice of introducing heated air into some of the cleaning devices themselves is widely employed.

SIGNIFICANCE OF DRYING AS AN AID IN CLEANING

The seed cotton drier was originally developed for the purpose of reducing the number of ginned bales penalized because of rough preparation. Now that the total number of bales of rough preparation is only about 3 percent of the total annual production, an additional function of the drier, namely, the function of increasing the cleanability of seed cotton by the lowering of its moisture content sufficiently to allow the trash to be freed more readily from the fiber, has gained in importance.

By making tests in connection with studies of driers as an aid in cleaning, the U. S. Ginning Laboratory determined the limits for cleaning machine-picked cotton insofar as cleaners and driers are concerned. The tests showed that the introduction of heated air into the cleaning machinery itself produced a noticeable increase in the quantity of trash removed (table 1).

Table 1.--Effects of drying with and without heated air and specified cleaning machinery on the cleaning of five varieties of machine-picked cotton

Cleaning machinery	Heated air	Moisture content: Wagon sample	Moisture content: Feeder sample	Trash content 1/: Wagon sample	Trash content 1/: Feeder sample	Trash removed per 1,500 lb. of seed cotton
		Percent	Percent	Pounds	Pounds	Pounds
Large extractor-feeder	No	16.0	15.1	107.7	57.4	50.3
	Yes	16.0	13.8	107.7	50.2	57.5
12-cylinder cleaner, large extractor-feeder	No	16.0	14.8	107.7	47.7	60.0
	Yes	16.0	12.9	107.7	45.8	61.9
12-cylinder cleaner, master extractor, large extractor-feeder	No	16.0	14.6	107.7	47.1	60.6
	Yes	16.0	12.0	107.7	44.4	63.3

1/ As determined by Fractionator Tests--results in terms of 1,500 pounds of seed cotton.

Examination of the drying test results showed that the effect of drying follows the usual pattern in that as the moisture content of the cotton is decreased the amount of trash removed by the cleaners is increased (table 2). In these tests, the increase in drying conditions from only one tower at 160° F., to the tower 160° F. plus 15-cylinder cleaner 160° F., and extractor-feeders 140° F. combination yielded a one-third grade increase on hand-harvested cotton regardless of harvesting stage. Further drying by the tower 200° F., 15-cylinder cleaner 200° F., and extractor-feeders 140° F. effected practically no additional grade increase although some slight grade index increase was in evidence for the midesason and late-season cottons.

Thus far, this report has dealt only with the effect of drying seed cotton as it affects the cleaning processes, but another and important factor of cotton quality is also being affected by the drier. Study of the upper half mean length revealed that as the moisture content of the cotton decreases owing to increased drying, the fiber length as measured by the fibrograph decreases. (Further reference to this factor may be found under the heading Cotton and Cottonseed Quality, p. 7).

EFFECTS OF CURRENT DRYING PRACTICES

Efficiency of Cleaning Devices

Field tests made recently in commercial gin plants indicated that in some sections of the Cotton Belt cotton has been overdried, sometimes with driers operated at drying air temperatures as high as 300° but seldom above that, because of fire hazards. On occasion, two driers, and even three at times, were operated in combination with cleaning equipment in the ginner's effort to obtain maximum grade improvements through more efficient cleaning. This malpractice was found in some of the areas where machine picking took place. Ginners apparently find drying by means of a series of driers operated at high drying air temperatures to be very helpful in cleaning roughly harvested cotton to improve the grade. These driers are employed regardless of any staple length penalties and bale weight losses that may occur.

Field observations revealed the fact that ginners use much higher air temperatures in drying machine-picked cotton than those used in drying hand-picked cotton, and that this practice is rather widespread. Moreover, where gins are equipped with two and three driers, it is sometimes the practice to bypass at least one drier in handling hand-picked cotton. In the case of machine-picked cotton, all driers are generally used, with the first two operating at relatively high drying air temperatures while the third one is usually supplied with moderately warm air.

Table 2.--Effects on foreign matter and moisture content, classification, and fiber data from the use of various amounts of drying on early-season, midseason, and late-season hand-harvested seed cotton to facilitate cleaning

Foreign matter and moisture contents, classification, and fiber data	Time and method of harvesting								
	Early-season hand-picked			Midseason hand-picked			Late-season hand-snapped		
	Cleaning and drying setup								
	No. 1 1/	No. 2 2/	No. 3 3/	No. 1 1/	No. 2 2/	No. 3 3/	No. 1 1/	No. 2 2/	No. 3 3/
Foreign matter content:									
Wagon sample ....percent..	1.9	1.9	1.9	3.0	3.0	3.0	28.3	28.3	28.3
Feeder sample ....percent..	.4	.4	.3	1.0	.6	.6	3.8	2.8	2.2
Foreign matter removed by cleaners ....percent..	78.4	78.9	84.2	67.0	80.0	80.0	86.6	90.1	92.2
Moisture content:									
Wagon sample ....percent..	11.1	11.1	11.1	18.1	18.1	18.1	9.2	9.2	9.2
Lint sample ....percent..	6.9	6.1	5.0	7.0	4.8	4.8	4.8	4.6	5.1
Classification: 4/									
Grade index 5/	99.8	102.3	102.3	94.5	95.5	95.0	80.5	82.0	82.7
Classer's designation	M	SM	SM	SLM	SLM+	SLM+	SGO+	LM	LM
Staple length ...... 1/32 inch..	34.5	34.5	34.3	34.0	34.0	34.2	32.5	32.5	32.7
Fiber data:									
Upper half mean ....inches..	1.12	1.10	1.09	1.12	1.09	1.09	1.06	1.08	1.06
Uniformity ratio ....index..	80	79	78	70	74	72	69	72	72
Strength, 1,000 lb. per sq. in.	84	86	85	82	80	83	79	76	76

1/ Tower drier 160° F., 6 cylinder cleaner, bur machine, 15 cylinder cleaner, and extractor-feeders.
2/ Tower drier 160° F., 6 cylinder cleaner, bur machine, 15 cylinder cleaner 160° F., and extractor-feeders 140° F.
3/ Tower drier 200° F., 6 cylinder cleaner, bur machine, 15 cylinder cleaner 200° F., and extractor-feeders 140° F.
4/ Average of two classifications.
5/ SM = Strict Middling = 104; M = Middling = 100; SLM = Strict Low Middling = 94; LM = Low Middling = 85; SGO = Strict Good Ordinary = 76.

In a study of gins in the Yazoo-Mississippi Delta in 1949, it was found that gins not equipped with lint cleaners generally employed higher drying air temperatures than did those having lint cleaners. 1/ The action of lint cleaners enabled the gins to obtain maximum grades without resorting to the use of excessive heat in drying to facilitate cleaning.

On a seasonal basis, the Yazoo-Mississippi Delta study showed that the grades of machine-picked, as well as hand-picked, cotton ginned at moderately equipped plants using lint cleaners compared very favorably with the grades obtained for the respective harvesting methods at plants having very elaborate combinations of seed cotton drying and cleaning machinery but no lint cleaners. Lint moisture content differences and associated bale weight differences in favor of the moderately equipped lint cleaner gin plants amounted to 6 pounds per bale in the case of machine-picked as well as hand-picked cottons. The lowest average seasonal moisture content was 3.9 percent for machine-picked lint ginned on the very elaborately equipped plants, and the highest average was 5.3 percent for hand-picked cotton ginned on the lint cleaner gins having only a moderate amount of seed cotton drying and cleaning machinery. Associated with the increased drying and lint moisture reduction was a tendency toward lower average staple length for the gins having very elaborate combinations of seed cotton drying and cleaning equipment.

Although the tests on hand-picked cotton showed that intense drying of clean cotton produced doubtful overall benefits, grade benefits on machine-picked cotton were very pronounced as a result of following this practice to increase trash removal by the cleaners. In general, the greater the moisture removal from increased drying, the higher was the grade of the resulting ginned lint.

Efficiency of Ginning

Analysis of results from a series of drying tests at the U. S. Cotton Ginning Laboratory showed a definite relationship between lint moisture and ginning time. This relationship is not linear but follows a curve with the time required for ginning a bale of cotton increasing as the seed cotton becomes drier (fig. 1). Although actual ginning times will vary with local gin and cotton conditions, the tests showed that ginning time is not appreciably effected until the moisture content of the lint is reduced to about 7 percent. Below this moisture content the ginning time increases more rapidly. Tests have shown that there is a direct relationship between moisture content of the fibers and ginning time with a given seed roll density.

1/ Gerdes, Francis L. "Cotton Lint Cleaning at Gins--An Evaluation from the Standpoint of Cotton Quality and Economic Factors." U. S. Dept. Agr. (May 1951.)

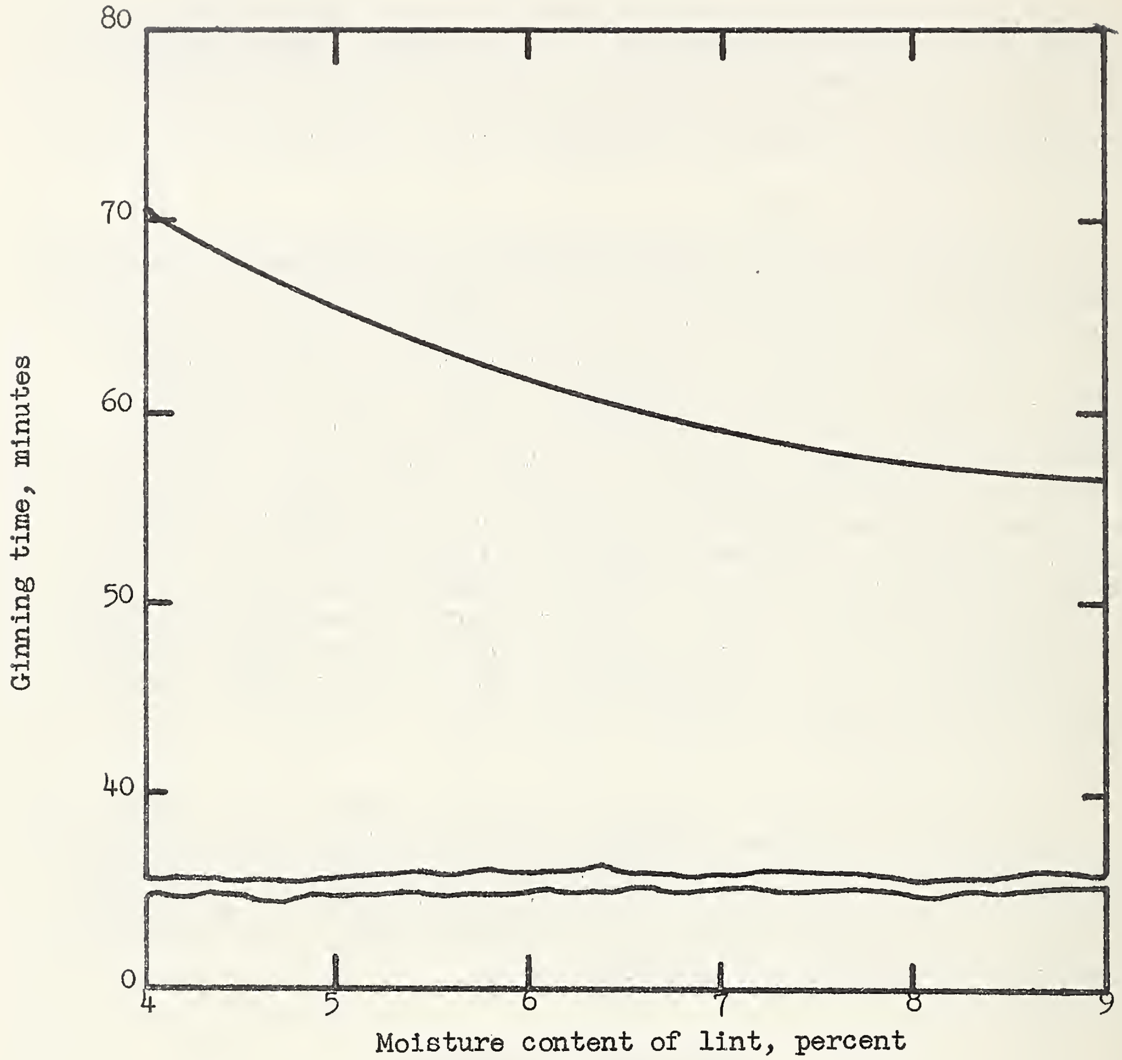

Figure 1.--The effect of drying seed cotton on the time required to gin 500 pounds of lint on one 80-saw gin stand.

Drying enables ginners to maintain adequate ginning capacity by making it possible to employ a slightly denser seed roll than otherwise and eliminating virtually all chokage associated with dampness of the fiber. Continuous ginning without chokage or breakdown is an important factor and contributes to efficiency in ginning.

Loss in bale value results from excessive drying in the way of bale weight reduction due to increased overflow cotton which accompanies the increased ginning time. This overflow cotton, unless routed directly to the distributor, will undergo still further drying and cleaning which would not be beneficial to the bale because the grade of the lint was already set by the cotton ginned at the beginning of the ginning operation on the bale.

Efficiency of Packaging

Although reducing the moisture content during the drying process increases ginning efficiency, it has a tendency to slow down the bale-pressing rate. 2/ That is, peak hydraulic pressure required to press a standard bale of cotton to gin bale density is increased (fig. 2). This increase in peak pressure requirements is owing to the increased resiliency, and thus increased resistance to compression, of the fiber as the moisture content decreases and is reflected as increased horsepower requirements for both the tramper and the bale-pressing system.

A very noticeable effect of this increased resiliency of overdried cotton is the shearing of bale ties on such bales of lint. Shearing of ties on flat bales of normal weight and average moisture content is practically nonexistent.

Since pressing machinery for handling bales of normal weight and normal moisture content is actually overloaded toward the end of the pressing cycle, the increased workload due to cotton of subnormal moisture content accounts for much of the belt slippage, motor burnouts, and ram-packing leakage found in gins employing more drying than is necessary to give good cleaning and smooth preparation of the ginned sample.

Cotton and Cottonseed Quality

Overdrying of seed cotton has a variety of effects on the quality elements of the ginned lint, spun yarn, and cottonseed. Some of these quality elements are improved, others are lowered, and a few are not changed (table 3). Very apparent is the effect of drying on grade and upper half mean length. The grade increase as drying was increased was owing to decreased rough preparation coupled with increased cleaning

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2/ Wright, J. W., Gerdes, F. L., and Bennett, C. A. "The Packaging of American Cotton and Methods for Improvement." U. S. Dept. of Agri. Circ. No. 736

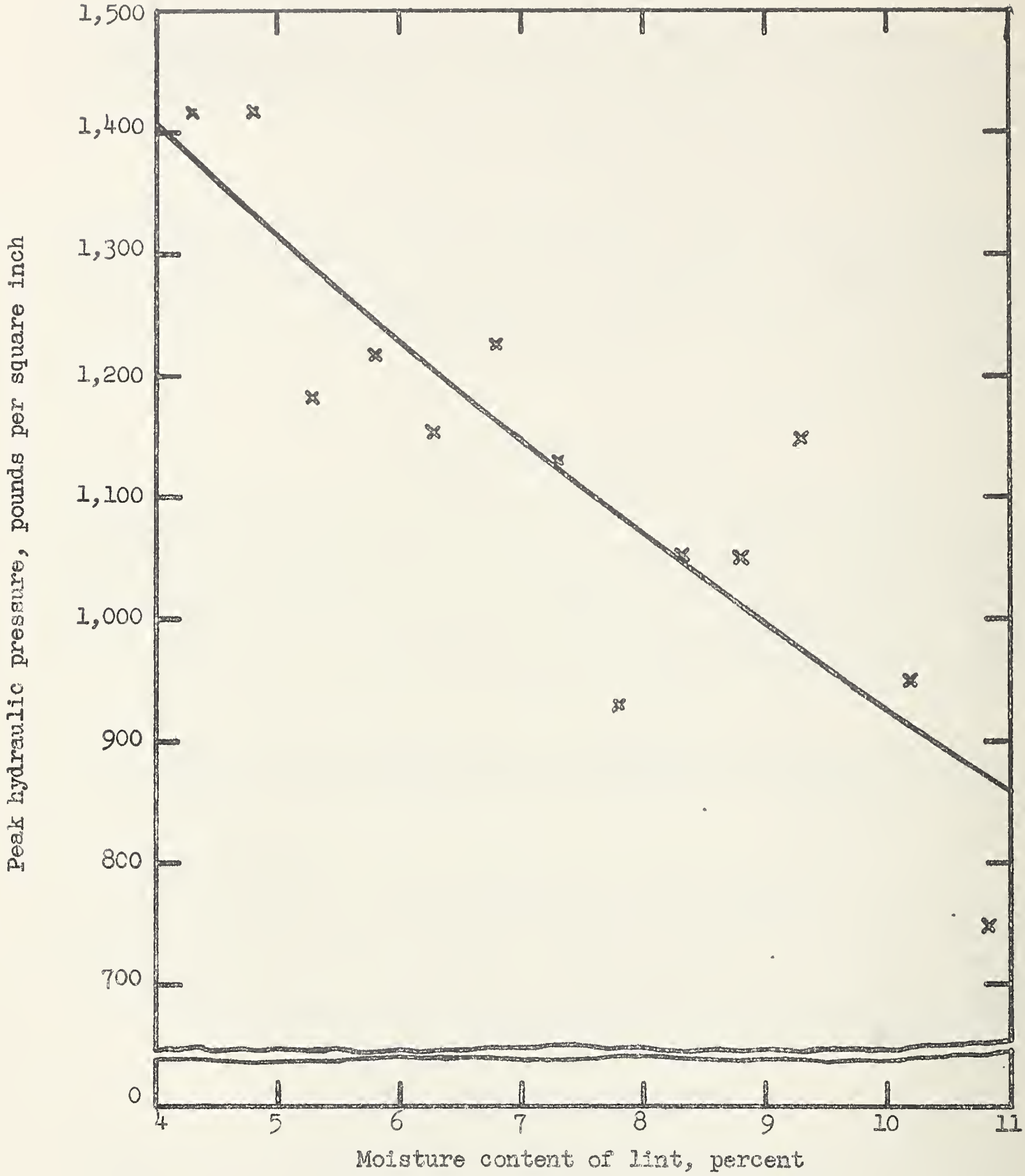

Figure 2.--The effect of lint moisture content on peak hydraulic pressure required to press 500 pounds of lint to flat bale density.

efficiency. Very heavy drying (below 5 percent lint moisture) did not result in additional grade improvement, but did affect the upper half mean length adversely. Although the tensile strength was not noticeably affected, a reduction in yarn strength is usually associated with decreased upper half mean length. Test data show that yarn appearance is another quality element that may be adversely affected by overdrying. There is a tendency for the nep count to increase with increased drying.

The effect of seed cotton drying on linters content of the seed is readily apparent (table 3). When too much drying is done, the gin saws have a tendency to clean the seed too closely of linters fiber. The additional removal of linters is frequently reflected as an increased manufacturing waste, reduced uniformity of fiber length, and, when lint cleaning follows ginning, an additional substaple fiber loss is evidenced in the lint cleaner waste. Also, heavy drying frequently induces the chipping of the seed coat by the gin saws--an effect noticeable particularly as imperfections in yarn spun from overdried cotton.

Table 3.--Effects of seed cotton drying on specified quality elements of ginned lint, yarn, and cottonseed, by lint moisture content

Lint moisture content (percent)	Lint grade	Staple length	Upper half mean length	Tensile strength	22s yarn: skein strength	Cotton-seed linters
	Designation	1/32 inch	Inches	1,000 lb. per sq. in	Pounds	Percent
9.5......	SLM+	34.0	1.02	73	96	11.2
8.0......	M	34.2	1.02	73	96	11.3
7.5......	M	33.8	1.02	74	96	11.3
6.0......	M	34.0	1.02	72	99	11.0
5.5......	M	34.2	.99	73	93	10.8
4.5......	M	33.7	1.00	73	93	10.5
4.0......	M	34.0	.99	73	94	10.3

The effect of current drying practices on the quality of cottonseed is much less pronounced than their effect on lint quality (table 4). 3/.

Table 4.--Effects of artificial drying of seed cotton on the moisture content and free fatty acid content of cottonseed

MOISTURE CONTENT 12 PERCENT AND MORE

Condition of seed cotton	Moisture content		Free fatty acid content	
	At ginning	After 90 days storage	At ginning	After 90 days storage
	Percent	Percent	Percent	Percent
Undried	15.7	14.5	0.7	12.4
Dried at 160° F.	15.1	14.3	.7	10.4
Dried at 190° F.	15.3	14.1	.7	9.4
Dried at 220° F.	15.0	14.1	.7	7.5
MOISTURE CONTENT BELOW 12 PERCENT				
Undried	10.3	9.7	0.6	0.6
Dried at 160° F.	9.2	9.6	.6	.7
Dried at 190° F.	9.1	9.5	.6	.6
Dried at 220° F.	9.7	9.6	.6	.7

Because the seed cotton is in the drying system only briefly, almost all the moisture removed is from the fiber. Moisture removal from cottonseed is negligible and cannot be considered as a significant benefit from the drying of seed cotton.

POSSIBILITIES OF OBTAINING BOTH EFFECTIVE CLEANING AND PRESERVATION OF FIBER QUALITY THROUGH CONTROL OF MOISTURE CONTENT IN SEED COTTON

Examination of the moisture content of cotton ginned in the Yazoo-Mississippi Delta on elaborately equipped gins during the period 1947-49 indicated that almost 80 percent of both hand- and machine-picked harvestings yielded ginned lint with a moisture content of less than 6 percent (table 5). An average of 45 percent of the crop in that area, during the 3 seasons, showed a lint moisture content which averaged less than 5 percent.

3/ Rusca, Ralph A., and Gerdes, Francis L. "Effects of Artificially Drying Seed Cotton on Certain Quality Elements of Cottonseed in Storage." U. S. Dept. of Agr. Circ. No. 651 (July 1942).

About 16 percent of the hand-picked and less than 25 percent of the machined-picked cottons produced lint which was below 4 percent in moisture content. Thus, since elaborately equipped plants are typical of gins in the Delta area, four-fifths of a crop may be ginned in a manner to turn out lint of less than 6 percent in moisture content. About 90 percent of the ginnings showed moisture content averages of less than the 7 percent which is normal for bales opened at cotton textile mills. 4/

Table 5.--Moisture content of lint from hand-picked and machine-picked cottons ginned on elaborately equipped gins in the Yazoo-Mississippi Delta, crop years, 1947-49 1/

Moisture content group (percent)	Percentage of hand-picked cotton for --				Percentage of machine-picked cotton for --			
	1947	1948	1949	3-year average	1947	1948	1949	3-year average
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
7.0 and more	12.8	4.4	9.4	7.2	10.8	7.6	10.1	8.6
6.0 to 6.9--	21.1	12.8	12.8	13.7	17.2	12.9	7.3	11.6
5.0 to 5.9--	28.9	34.4	34.0	33.6	24.7	26.5	17.7	23.9
4.0 to 4.9--	26.9	33.8	23.4	29.2	32.2	33.5	25.8	31.2
Below 4.0---	10.3	14.6	20.4	16.3	15.1	19.5	39.1	24.7
Total-----	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Elaborately equipped gins employed 2 drying systems, 2 overhead cleaners, in addition to overhead bur extraction equipment, and extractor-feeders.

Although drying practices since 1949 have been modified to preserve fiber quality, there is still an average difference in excess of 1-1/2 percent (table 6) in lint moisture content of bales as turned out at gins and bales as received at mills. Ginners are confronted with the problem of providing gin turnouts that will satisfy producers as well as that of coping with the difficulties encountered because of static electricity in ginning cotton of low moisture content. Therefore, the ginners have sought means for adding moisture to cotton during the process of ginning. In these efforts, recognition has been made of the fact that producers, like others who handle cotton, have an interest in the benefits from gains in weight by bales of subnormal moisture content in the journey of cotton from gins to mills.

4/ Martin, William J., and McLure, Joe H. "Market Outlets for Cotton in Some of the Principal Cotton Fabrics." Prod. Mktg. Admin. U. S. Dept. Agr. (February 1950.)

Table 6.--Average moisture content of lint from hand-picked and machine-picked cottons ginned on elaborately equipped gins in the Yazoo-Mississippi Delta, Crop years, 1947-49

Type of harvest	Moisture content of lint			
	1947	1948	1949	Average
	Percent	Percent	Percent	Percent
Hand picked	5.5	4.7	4.5	4.7
Machine picked	5.4	4.8	4.8	4.8

In searching for some means to control static, ginners have attempted to restore moisture to the lint in the gin in various ways, such as hanging wet bagging from the rafters of the gin building and using spray nozzles in the wagon telescope, fan inlets, cleaners, and at other places throughout the ginning system. Ginners who have tried using water, steam, and wetting agents have met with varying degrees of success, and at times have aided gin operation. Although an entirely satisfactory method for the control of static has not yet been found, some rather interesting observations have been made.

The effect of adding moisture at various points in the ginning system has undergone limited investigations at the U. S. Cotton Ginning Laboratory. Using cottons which averaged 11 percent and 9 percent seed cotton moisture content, respectively, the tests were conducted with 4 conditions as follows:

1. Seed cotton ginned without moisture application in either the wagon telescope or the lint slide.

2. Seed cotton ginned with moisture application in the wagon telescope.

3. Seed cotton ginned with moisture added on the lint slide.

4. Seed cotton ginned with moisture application in the telescope and on the lint slide.

Laboratory tests, including tests of moisture content and fiber quality of the lint and moisture content of the seed cotton, showed results which indicate that it is feasible to apply moisture in the ginning process without harmful effects to the ginned products. Also, the results showed that there is a limit to the amount of moisture that can be absorbed in an air line and retained by the cotton through the ginning and pressing processes with the use of the devices tested for the addition of moisture.

In tests on seed cotton which averaged 11 percent in moisture content, the application of moisture at the wagon telescope at a rate of 20 pounds per bale resulted in only a slight increase in moisture

content of the seed cotton as it reached the feeder in comparison with the moisture content of the control or unconditioned seed cotton sampled at the feeder. The seed cotton retained only 1 pound of the 20 pounds of moisture emitted by the nozzle in the telescope. When moisture was added on the lint slide only, at a rate of 8 pounds per bale, the lint retained only 3 pounds. Moisture application to the telescope and the lint slide at the rates of 20 and 8 pounds respectively, caused an increase of only 6 pounds in bale weight (table 7).

In the case of the seed cotton averaging 9 percent moisture content, the addition of 20 pounds of moisture per bale at the telescope only increased the seed cotton weight 12 pounds per bale. The lint retained moisture sufficient to increase the bale weight only 5 pounds per bale. When moisture was added on the lint slide at a rate of 8 pounds per bale, 6 pounds were retained by the lint. When moisture was added at the wagon telescope and on the lint slide, the final moisture content of the lint was 7.5 percent which is considered normal as compared with 4.9 percent for the lint ginned without moisture being applied. This increase averaged 13 pounds per bale.

The results of these tests on the moisture retention capacity of cotton of average and low moisture content indicate that there is a limit to the amount of moisture that cotton will absorb and retain when the moisture is added by conventional methods in the short time required for ginning a bale of cotton. It was also noted that cotton of near normal moisture content will absorb less moisture proportionately than will cotton of subnormal moisture content. For example, when moisture was added to the lint on the lint slide at a rate of 8 pounds per bale, the lint which averaged 8.2 percent in moisture content absorbed only 3 pounds of moisture as compared with 5 pounds absorbed by the lint which averaged 4.9 percent in moisture content. There were no quality benefits derived from adding moisture to cotton of normal moisture content or to cotton of subnormal moisture content after ginning. The addition of moisture to very dry cotton at the telescope effected an average of 1/16-inch increase in staple length which was substantiated by fiber laboratory tests whereas the addition of moisture on the lint slide only produced no improvement over the dry control.

It may be concluded from these test results that except as an aid in the control of static electricity, or slightly increasing the bale weight, there is no benefit, such as quality improvement, to be derived from adding moisture to ginned lint. On the other hand, proper conditioning of the seed cotton prior to the feeding of cotton to the gin stand materially aids in preserving fiber length. This is explainable on the basis of two facts: (1) When the moisture content of the fiber is near normal, the short linters fibers are not removed from the seed and placed in the lint to reduce the average fiber length; and (2) adequate moisture in the fibers prevents fiber brittleness and associated breakage by the saws in the process of separating lint from the seed.

Table 7.--Effects of adding moisture to seed cotton and ginned lint, during the ginning process, on the moisture content and quality of ginned products

SEED COTTON OF AVERAGE MOISTURE CONTENT

Test item	Moisture content of-- Wagon sample	Feeder sample	Ginned lint	Cotton-seed	Actual wt. of moisture retained per bale of lint	Classification 1/ Grade	Staple	Fiber data: Upper half mean length	Uniformity ratio	Strength
	Percent	Percent	Percent	Percent	Pounds	Index	1/32 in.	Inches	Index	1,000 lb. per sq. in.
Control (no moisture added)	11.0	10.9	8.2	11.2	---	103.8	35.2	1.06	78	84
Moisture added in wagon telescope at rate of 20 pounds per bale	11.0	11.1	8.4	11.3	1	103.5	35.2	1.08	78	84
Moisture added on lint slide at rate of 8 pounds per bale	11.0	10.9	8.8	11.4	3	103.2	35.8	1.08	76	84
Moisture added in wagon telescope at rate of 20 pounds and on lint slide at rate of 8 pounds per bale	11.0	11.1	9.3	11.3	6	103.2	35.8	1.08	78	83

SEED COTTON OF SUBNORMAL MOISTURE CONTENT

Test item	Wagon sample	Feeder sample	Ginned lint	Cotton-seed	Actual wt. of moisture retained per bale of lint	Grade	Staple	Upper half mean length	Uniformity ratio	Strength
Control (no moisture added)	9.1	7.6	4.9	9.1	--	104.2	34.0	1.03	76	82
Moisture added in wagon telescope at rate of 20 pounds per bale	9.1	8.4	5.8	9.2	5	103.8	35.0	1.06	76	82
Moisture added on lint slide at rate of 8 pounds per bale	9.1	7.6	6.0	9.1	6	103.6	34.5	1.03	78	82
Moisture added in wagon telescope at rate of 20 pounds and on lint slide at rate of 8 pounds per bale	9.1	8.4	7.5	9.3	13	104.1	35.1	1.06	78	83

1/ Average of 2 classifications.

A further confirmation of benefits associated with proper conditioning of seed cotton was evidenced in laboratory tests carried out in 7 replications which indicated that fiber breakage may be avoided by restoring the lint to normal moisture content after cleaning and prior to ginning (table 8). In these tests the moisture content of the seed cotton was reduced by successive treatments through a cotton drier to provide test material. One-third of the cotton was divided into 7 replicate lots and ginned immediately; one-third was stored in the gin building for 1 week and allowed to reach equilibrium with the atmosphere; and one-third was stored for 1 week in an air-conditioned room having a relative humidity of 65 percent and a temperature of 70° F., and then divided into 7 replicate lots each for ginning. The ginned lint samples were classed and subjected to fiber analyses and moisture tests. The 7 samples representing each condition were composited for spinning tests.

Table 8.--Effects of conditioning and increasing moisture content of dry seed cotton, prior to ginning, on the classification, fiber quality, and spinning value 1/

Test item	Ginning condition: Ginned immediately after drying	Ginning condition: Stored in gin house for 1 week prior to ginning	Ginning condition: Stored in air-conditioned laboratory for 1 week prior to ginning
Wagon sample moisture---------percent--	10.1	--	--
Seed cotton moisture immediately after drying----------------------percent--	7.6	--	--
Feeder sample moisture at time of ginning---------------------percent--	7.2	8.6	9.0
Lint moisture-----------------percent--	3.7	7.0	6.8
Grade 2/------------------------index--	87.0	86.0	85.9
Staple 2/------------------32d inch--	32.7	33.6	33.4
Upper half mean (fibrograph)---inches--	1.00	1.03	1.04
Mean length (fibrograph)--------inches--	.74	.75	.76
Uniformity ratio----------------index--	74	73	74
Strength--------1,000 lb. per sq. in.--	82	81	83
Linters content of cottonseed-percent--	11.0	11.8	11.4
Upper quartile length (array)--inches--	1.15	1.20	1.21
Mean length (array)------------inches--	.88	.93	.94
Coefficient of variation (array)--------	40	38	38
Total manufacturing waste-----percent--	11.2	10.2	11.4
22s yarn strength--------------pounds--	107	111	108
36s yarn strength--------------pounds--	56	61	60
60s yarn strength--------------pounds--	29	31	30
22s yarn appearance grade 3/----index--	100	100	100
36s yarn appearance grade 3/----index--	90	90	90
60s yarn appearance grade 3/----index--	90	90	90

1/ Average of 7 replications.
2/ Average of 3 classifications.
3/ C+ = 100, C = 90.

The 7 lots of cotton ginned in a very dry condition produced lint that averaged 3.7 percent in moisture content. The moisture content of fibers of the lots conditioned in the gin building and in the laboratory had increased by the time of ginning to an average of 7.0 percent for the former and 6.8 percent for the latter lots. Although the grade of the cotton was not affected by the increased moisture in the fiber of the conditioned cotton, staple length was increased by almost 1/32 inch. Also, fibrograph and Suter-Webb sorter length tests substantiated the classer's findings. Linters tests made on the cottonseed indicated that a more nearly perfect separation of usable fibers was accomplished on the conditioned than on the dry lots, explaining in part the higher average fiber lengths with the conditioned lots. Doubtless, more linter fibers were removed by the gin saws on the dry than on the conditioned lots. Also, fiber breakage during the ginning process and reductions in fiber length were more evident with the dry fibers than with the fibers of normal moisture content.

The spinning test results reflected the benefits which may be derived by proper conditioning of dry seed cotton prior to ginning. The strength of the yarn representing the conditioned lots was consistently higher than that of the yarn representing the dry ginned lots.